INTEGRATION WITH OTHER RESTORATION PROGRAMS

Many programs and projects aim to protect, restore, and enhance wetland and open water habitats in the San Francisco-San Joaquin Bay-Delta estuary. These include:

- Bay Area Aquatic Habitats Planning Group;
- Cache Creek Corridor Restoration Plan;
- California Wetland Riparian Geographic Information System Project;
- Governor's California Wetland Conservation Policy;
- Inland Wetlands Conservation Program;
- Montezuma Wetlands Project;
- National Estuarine Reserve Research System;
- North Bay Initiative;
- North Bay Wetlands Protection Program;
- San Francisco Bay Regional Water Quality Control Board, and San Francisco Bay Conservation and Development Commission - Regional Wetlands Management Plan;
- San Francisco Estuary Project;
- Tidal Wetlands Species Recovery Plan;
- Wetland Reserve Program; and
- Yolo Basin Wetlands Project.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

The aquatic habitat plant community group is linked to other habitats that include open water, shallow water, emergent wetland, and riparian areas, and to associated wildlife guilds. It is also linked to physical processes that include streamflow, sediment supply, geomorphology, and tides. Secondary ecosystem functions and processes that are linked with the aquatic habitat plant community group include current velocities; floodwater and sediment detention and retention; vegetation succession, overbank flooding, and floodplain inundation; and primary production. Stressors that affect this plant community group include levees, bridges, and bank protection; dredging; non-native species; dams, reservoirs, and other human-made structures; water management; gravel mining; contaminants; and human disturbance.

OBJECTIVE, TARGETS, AND ACTIONS

The Strategic Objective is to enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

SPECIES TARGETS: The target for all plant communities is to maintain the present distribution and abundance and ensure self-sustaining communities in the long-term.

LONG-TERM OBJECTIVES: Develop protocols that protect existing and newly established shallow-water aquatic habitat plant communities within the Sacramento-San Joaquin Estuary from stressors and other factors. Additional efforts will need to be taken that assure newly established shallow-water aquatic plant communities consist of native aquatic vegetation and not introduced aquatic plant species (i.e. water hyacinth, hydrilla, and other aquarium trade plants).

SHORT-TERM OBJECTIVES: Establish aquatic habitat plant community in suitable areas within the Delta and Suisun Marsh. Evaluate and remove exotic plant species (i.e. water hyacinth) that out compete native aquatic vegetation. In addition, identify, reclaim, and protect areas that provide shallow-water aquatic plant communities from future development and dredging activities.

RATIONALE: Shallow-water plant communities were once abundant throughout the Sacramento-San Joaquin Estuary. Their decline came when the Delta and its associated channels were altered and dredged to form islands and exotic aquatic water plant species came into the system. The reduction in these shallow-water areas has resulted in the loss of both rearing and escape cover for many fish species that either reside in or pass through the Delta. In addition, increased shallow-water plant communities will assist in reducing turbidity and contaminate levels that exist within the system.

STAGE 1 EXPECTATIONS: Efforts will need to be undertaken that evaluate the extent of existing aquatic habitat plant community groups within the Estuary and the likely locations were additional habitats can be created and protected. Methods will also need to be

developed that examine the extent of exotic aquatic plant species within the Estuary and a method of control.

RESTORATION ACTIONS

The general target for restoring the aquatic habitat plant community group is to provide 500 acres in the Sacramento-San Joaquin Delta Ecological Management Zone and 500 acres in the Suisun Marsh/North San Francisco Bay Ecological Management Zone.

The following actions would help to achieve targets for the aquatic habitat plant community group restoration:

- Restore perennial shallow water habitat in concert with restoration of tidal brackish and freshwater marsh and tidal riparian plant habitat.
- Link restored areas with existing healthy habitats to provide a source of vegetative propagules and to create large contiguous areas of aquatic habitat.
- Focus restoration effort on leveed lands that have not yet experienced severe subsidence, such as leveed agricultural lands and industrial lands adjacent to Suisun Bay.
- Restore permanent open-water areas by establishing elevation gradients sufficient to maintain surface water through natural groundwater or surface-water recharge, or by pumping water into lowland areas.
- Propagate restored areas with pondweeds and control invasion by exotics until the community has become established.

TIDAL BRACKISH AND FRESHWATER MARSH HABITAT PLANT COMMUNITY GROUP

INTRODUCTION

Tidal brackish marsh habitat is located along the western edge of the Delta and in Suisun marsh. Most tidal freshwater marshes in the Delta occur as narrow, fragmented bands along island levees, channel islands, shorelines and levee blowout ponds.

Tidal brackish and freshwater marshes are important habitat areas for fish and wildlife dependent on marshes and tidal shallows and support several special-status plant species. The loss or degradation of historic tidal brackish and freshwater marshes has substantially reduced the habitat area available for associated plant, fish and wildlife species. Major factors that limit this resource's contribution to the health of the Bay-Delta are related to adverse effects of wetlands conversion to agricultural, industrial, and urban uses.

The vision for tidal brackish and freshwater marsh habitats is to restore large areas of connecting waters associated with tidal emergent wetlands and their supporting ecosystem processes. Achieving this vision will assist in the recovery of special-status plant populations depending on these habitats. It will also assist in the recovery of special-status fish populations and provide high-quality aquatic habitat for other fish and wildlife dependent on the Bay-Delta. Restoring tidal brackish and freshwater marsh would also result in higher water quality and increase the amount of shallow-water habitats; foraging and resting habitats and escape cover for water birds; and rearing and foraging habitats, and escape cover for fish. The vision for this habitat type is to protect existing tidal brackish and freshwater marshes from degradation or loss and to increase wetland habitat. Achieving this vision will assist in the recovery of special-status plant, fish, and wildlife populations, and provide high-quality habitat for other fish and wildlife dependent on the Bay-Delta.

RESOURCE DESCRIPTION

Tidal brackish marshes were once continuous from San Francisco Bay into the western Delta. Most remnants of these wetlands are narrow bands along the margins of San Pablo Bay and Suisun Marsh and Bay. Tidal brackish marshes have been substantially reduced as a result of reclamation and land use conversions to agricultural uses, actions that reduced the amount of land subject to tidal flooding.

Tidal brackish marshes are important habitats for plant, fish and wildlife species that are dependent on marshes and tidal shallows. These wetland areas serve as an important transitional habitat between open water and uplands. Furthermore, tidal exchange is the primary process that supports healthy tidal brackish marshes in the Bay-Delta. Tides flush the wetland system, replacing nutrients and balancing salinity concentrations. Land management practices such as diking have isolated most of the remaining brackish marsh wetlands from tidal flows.

Five distinct plant series are found in tidal brackish marshes; each of these is briefly described below.

PICKLEWEED SERIES: Pickelweeds (*Salicornia* species) are the dominant plants in this series. Other associated plant species can include alkali heath (*Frankenia salina*), arrow-grasses (*Triglochin* species), dense-flowered cordgrass (*Spartina densiflora*), dodder (*Cuscuta salina*), fat-hen (*Atriplex patula*), jaumea (*Jaumea carnosa*), saltgrass (*Distichlis spicata*), saltwort (*Batis maritima*), sea-blite (*Suaeda californica*), and/or sea-lavender (*Limonium californicum*). This plant series is generally less than 5 feet tall and the canopy can be continuous or intermittent.

SALTGRASS SERIES: Saltgrass (*Distichlis spicata*) is the sole or dominant grass in this series. Other associated plant species can include alkali cordgrass (*Spartina gracilis*), alkali muhly (*Muhlenbergia asperifolia*), alkali sacaton (*Sporobolus airoides*), Baltic rush (*Juncus balticus*), common pickleweed (*Salicornia virginica*), Cooper rush (*Juncus cooperi*), one-sided bluegrass (*Poa secunda*), sea-lavender (*Limonium californicum*), slender arrow-grass (*Triglochin concinna*), and/or yerba mansa (*Anemopsis californica*). Emergent alkali rabbitbrush (*Chrysothamnus albidus*) or iodine bush (*Allenrolfea occidentalis*) may be present. This plant series is generally less than 3.5 feet

tall and the canopy can be continuous or intermittent.

BULRUSH SERIES: Bulrushes (*Scirpus* spp.) are the dominant species in this series. Common plant species include California bulrush (*Scirpus californicus*), common three-square (*Scirpus americanus*), common tule (*Scirpus acutus*), Nevada bulrush (*Scirpus nevadensis*), river bulrush (*Scirpus fluviatilis*), and saltmarsh bulrush (*Scirpus maritimus*). Other associated plant species can include broadleaf cattail (*Typha latifolia*), narrowleaf cattail (*Typha angustifolia*), saltgrass (*Distichlis spicata*), slenderbeaked sedge (*Carex athrostachya*), southern cattail (*Typha domingensis*), umbrella flatsedge (*Cyperus eragrostis*), water-plantain (*Alisma plantago-aquatica*), and/or yerba mansa (*Anemopsis californica*). The species in this series are generally less than 13 feet tall and the cover can be continuous or intermittent.

CATTAIL SERIES: Cattails, including broadleaf cattail (*Typha latifolia*), narrowleaf cattail (*Typha angustifolia*), and southern cattail (*Typha domingensis*)(*Typha* spp.) are the dominant plants in this series. Associated plant species can include California bulrush (*Scirpus californicus*), common three-square (*Scirpus americanus*), common tule (*Scirpus acutus*), Nevada bulrush (*Scirpus nevadensis*), river bulrush (*Scirpus fluviatilis*), saltgrass (*Distichlis spicata*), saltmarsh bulrush (*Scirpus maritimus*), slender-beaked sedge (*Carex athrostachya*), umbrella flatsedge (*Cyperus eragrostis*), water-plantain (*Alisma plantago-aquatica*), and/or yerba mansa (*Anemopsis californica*). The plants in this series are generally less than 13 feet tall and the cover can be continuous, intermittent, or open.

COMMON REED SERIES: Common reed (*Phragmites australis*) is the dominant plant in this series. The community may include emergent shrubs and trees. However, few other species are generally present. Common reed generally grows less than 13 feet tall and the cover is typically be continuous.

Diking of historic wetlands greatly reduced the amount of tidally influenced marshes in the Delta. Reservoir operations and other water management practices that control California's inland water supplies have reduced saltwater intrusion into the Delta by retaining water during winter and releasing water during summer. These complex water management activities resulted in reduced saltwater intrusion into the Delta, thereby reducing the area that can support brackish wetlands. Preservation of the largest single area of brackish marsh habitat in California has been accomplished at Suisun Marsh through implementation of a complex water control system.

Prior to the mid-1800s, extensive areas of tidal freshwater marsh habitat occurred throughout the Central Valley, particularly in the Delta. A complex network of rivers, sloughs, and channels connected low islands and basins that supported a diverse and dense variety of freshwater marsh vegetation. This freshwater marsh vegetation supported a diversity of plant, fish and wildlife species and ecological functions. Vast areas of the Sacramento-San Joaquin Valleys were commonly flooded in winter by a slow-moving blanket of silt-laden water. Flood control activities and land settlements in the late 1800s and early 1900s led to the development of leveed Delta islands. Levees and other land uses led to the loss of freshwater marshes in the Delta. Loss of wetlands has substantially reduced habitat for wetland wildlife species in the Bay-Delta system. Freshwater marsh losses have also substantially reduced the area available for the biological conversion of nutrients in the Delta. The Delta contains insufficient wetland area to provide adequate levels of nutrient transformation, which results in lower quality water in San Francisco Bay.

The loss of freshwater marshes has substantially reduced the habitat of several plant and wildlife species. Some species have been designated as California or federal special-status species and are threatened with local extermination. At least eight special-status plant species, Suisun Marsh aster, California hibiscus, bristly sedge, Jepson's tule pea, Mason's lilaeopsis, marsh mudwort, Sanford's arrowplant, and marsh scullcap, are native to the Delta. Most of these plants are adapted to a complex tidal cycle and are typically found with more common vegetation such as tule, cattails, common reed, and a great diversity of other herbaceous plant species. Changes in habitat conditions have allowed the invasion of hundreds of non-native weedy plant species. Some of these species, such as water hyacinth, now clog waterways and irrigation ditches and reduce overall habitat quality for native plants and wildlife. Over 50 species of birds, mammals, reptiles, and

amphibians use freshwater marshes in the Delta. Populations of some wildlife species that are closely dependent on freshwater marshes, such as the California black rail, giant garter snake, and western pond turtle, have been substantially reduced in the Delta and designated as special-status species. A few wetland-associated species, such as waterfowl and egrets, have successfully adapted to foraging on some types of Delta croplands converted from historic wetland areas.

Isolating wetlands from tidal flows and removing Delta island freshwater marshes changed the ecological processes that support wetlands. Removing the perennial water and vegetation from the organic soils of Delta islands resulted in soil oxidation and, subsequently, the subsidence of the interior islands. Loss of these tidal flows to islands has reduced habitat for native species of fish, plants, and wildlife; reduced water quality; and decreased the area available for floodwater dispersion and suspended silt deposition.

High tidal velocities in confined Delta channels continue to erode remaining freshwater marshes at a greater rate than habitat formation. Continued erosion reduces the amount of freshwater marshes and changes the elevation of the land. Elevation affects the types of plant species that can grow depending on a species' ability to tolerate flooding. Flood protection and levee maintenance continue to impair wetland vegetation and prevent the natural reestablishment of freshwater marshes in some locations.

Wind, boat-wake waves, and high water velocities in confined channels actively erode the soil needed to support remnant freshwater marshes. Continued erosion of existing habitat, such as midchannel islands and levees and levee berms, is currently the primary cause of habitat loss in the Delta.

VISION

Restoration of tidal brackish and freshwater marsh habitat would focus on protecting and improving important existing wetlands, such as channel islands, and restoring wetlands in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Management Zones.

Restoring tidal brackish marsh is dependent on restoring tidal flows, establishing and maintaining healthy estuarine salinity gradients appropriate, and reestablishing elevation gradients from open water to uplands. The following actions would help achieve saline emergent wetlands restoration:

- restore tidal flows to diked wetlands by breaching dikes in suitable areas;
- establish desirable estuarine salinity gradients by managing water diversions and water releases from upstream reservoirs to control seasonal freshwater inflows to the Delta;
- balance seasonal flows from reservoirs for fisheries, water conveyance, flood control, and the needs of other habitats; and
- restore a more natural elevation gradient in wetlands to allow a greater diversity of native saline plant species, including special-status species, that are adapted to different elevations and provide a broader range of habitats for wildlife.

Enhancing and increasing tidal brackish marsh habitat would also help to increase water quality. Areas restored to tidal flow will contribute to the aquatic foodweb of the Bay-Delta and provide fish rearing habitat. Restoring tidal brackish marshes would improve the ecological value of adjacent associated habitats, including tidal aquatic habitats, and will provide an important transitional zone between open water and uplands.

Other habitat restoration efforts will be directed toward reestablishing native plant species, controlling competitive weedy plants, increasing the quality of adjacent upland habitats to provide refuge for wildlife during high tides, and modifying land use practices that are incompatible with maintaining healthy wetlands. Restoring saline emergent wetlands would be coordinated with restoration of other habitats to increase overall habitat values. For example, saline emergent wetland greatly increases wildlife habitat quality of deep and shallow open-water areas and adjacent grasslands.

To prevent further loss of existing freshwater marshes, erosion rates must be reduced. Inchannel islands and levee berms are of particular concern. Erosion losses could be offset by allowing deposition and wetland

establishment. Wetlands erosion could be reduced by reducing boat speeds where wetlands are subject to boat-wake-induced erosion (e.g., Snodgrass Slough). Constructing protective structures around eroding channel islands would weaken wave action (e.g., wave barriers and riprap groins) in a way that retains habitat value for fish and wildlife. Protecting inchannel islands from further erosion and connecting with larger islands would provide greater protection for this unique habitat.

Restoring freshwater marsh habitat is dependent on local hydrological conditions (e.g., water depth, water velocity, and wave action); land elevation and slope; and the types and patterns of sediment deposition. The approach to restoring freshwater marshes would include:

- reestablishing the hydraulic, hydrologic, and depositional processes that sustain freshwater marshes and inchannel islands;
- restoring a full spectrum of wetland elevations to allow the establishment of a greater diversity of plant species, including special-status species adapted to different elevations within the tidal or water (nontidal sites) column; and
- providing a broader range of habitats for wildlife.

Restoration of freshwater marshes would be coordinated with restoration of other habitats to increase overall habitat values. Restoration would also include reestablishment of the full diversity of freshwater marsh plant associations to ensure that the habitat needs of special-status and other species that are dependent on specific vegetation associations are met.

Protecting and restoring freshwater marshes could be accomplished by implementing elements of existing restoration plans such as Central Valley Habitat Joint Venture; expanding State and federal wildlife areas to create additional wetland complexes; improving management of existing and restoring additional freshwater marshes on private lands; and reestablishing connectivity between the Delta and Delta islands, and between channels with their historic floodplains.

Major opportunities exist for restoring tidal freshwater marshes. Actions that would help restore fresh emergent wetlands include:

- Setbacks or breaches of island levees to allow water flows to naturally reestablish wetlands.
- Increase land elevations in the interior of Delta islands where subsidence has lowered land elevations below tidal emergent wetlands
- Use substrate materials to create levee berms at elevations necessary for freshwater emergent vegetation
- Modify, where consistent with flood control objectives, levee vegetation management practices to allow wetland vegetation to naturally reestablish.
- Reintroduce native wetland plants into suitable sites.

These protection and restoration strategies could be implemented by:

- establishing cooperative efforts between government and private agencies to coordinate the efficiency of implementing existing restoration strategies and plans;
- developing and implementing alternative land management practices on public lands to improve wetland habitat quality or promote habitat recovery, and provide incentives to private landowners to implement desirable land use practices;
- establishing additional incentive programs to encourage landowners to establish and maintain freshwater marsh wetlands; and
- protecting existing habitat areas from potential future degradation through acquisition of conservation easements or purchase from willing sellers.

Restoration of stream meander belts and the process of overbank flooding along major tributaries to the Bay-Delta as proposed in the ERPP in other ecological management zones will also create the conditions necessary for the natural reestablishment of freshwater marshes elsewhere in the Central Valley.

These protection and restoration needs could be met by establishing cooperative efforts between government and private agencies. This effort would coordinate implementation of existing restoration strategies and plans; develop and implement

alternative land management practices on public lands to improve wetland habitat quality or promote habitat recovery; provide incentives to private landowners to implement desirable land use practices; establish additional incentive programs to encourage landowners to create and maintain saline emergent wetlands; and protect existing habitat areas from future degradation through acquisition of conservation easements or purchase from willing sellers.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Efforts to restore tidal brackish and fresh emergent marsh habitat would involve cooperation with other wetland restoration and management programs. These include:

- Agricultural Stabilization and Conservation Service's Wetland Reserve Program.
- Wildlife Conservation Board's Inland Wetland Conservation Program
- restoration programs administered by Ducks Unlimited and the California Waterfowl Association
- the Suisun Marsh Protection Plan
- ongoing management of State and federal wildlife refuges and private duck clubs
- and the San Francisco Bay Wetlands Ecosystem Goals Project

Proposed ERPP targets may be adjusted to reflect goals identified by the San Francisco Bay Wetlands Ecosystem Goals Project. Restoration efforts would be conducted in cooperation with agencies or organizations with responsibility or authority for restoring wetland and aquatic habitats, including:

- U.S. Bureau of Reclamation
- California Department of Fish and Game,
- California Department of Water Resources,
- U.S. Fish and Wildlife Service,
- U.S. Army Corps of Engineers,
- and the Delta Protection Commission

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Tidal brackish and freshwater marshes are linked to other ecological elements in the Bay. Tidal exchange is an important ecological function that restores the proper salinity and nutrient balance and mixed fresh and estuarine waters.

Tidal brackish and freshwater marshes are closely linked to open water areas and upland habitats. The value of each habitat is increased by the presence and quality of the adjacent types of habitats. A variety of aquatic and terrestrial fish, wildlife and plant communities depend on healthy tidal brackish and freshwater marshes. These include Suisun Marsh aster, California hibiscus, bristly sedge, Jepson's tule pea, Mason's lilaeopsis, marsh mudwort, Sanford's arrowplant, and marsh scullcap and the salt marsh harvest mouse.

Tidal brackish marshes are impaired by reduced seasonal inflows of fresh water, land use, and loss of upland habitat, and introduction an proliferation of invasive salt marsh plant species. Stressors that have reduced the extent of fresh emergent wetlands include flood protection practices, levee construction, and the loss of tidal flow. Increased velocities in Delta channels causes erosion of wetlands and changes the elevation of the land. Wind and boat wake erosion also contribute to the loss of soil needed to support fresh emergent wetlands in area where midchannel islands and levee berms are present.

OBJECTIVE, TARGETS AND ACTIONS

The Strategic Objective is to enhance and/or conserve native biotic communities in the Bay-Delta estuary and its watershed.

SPECIES TARGETS: The target for all plant communities is to maintain the present distribution and abundance and ensure self-sustaining communities in the long-term.

LONG-TERM OBJECTIVES: Protect and restore, on a self-sustaining basis, throughout the Bay-Delta, multiple large areas of tidal brackish and freshwater marsh in association with tidal perennial and perennial

grassland to a point where all at-risk species that depend on the habitat are no longer at risk.

SHORT-TERM OBJECTIVES: Identify, locate, and conserve existing, high quality tidal brackish and freshwater marsh. Restore several large areas of tidal brackish marsh in the Suisun Marsh and several large areas of tidal freshwater marsh in the Delta.

RATIONALE: Tidal brackish and freshwater marsh wetlands are two habitats that support a diverse and unique plant assemblage. Some of the most endangered plants, such as the Suisun thistle, is found only in tidal brackish marsh wetlands in the Suisun Marsh. They merit special attention because their restoration is urgently needed for the benefit of many species, both plant and animal. They also represent, by acreage, some of the largest restoration projects that are likely to be attempted in the system. Prior to implementing larger scale tidal restoration projects, a determination will be made about whether suitable elevation, topography, and geomorphological conditions exist to allow the successful restoration of natural marsh building processes.

STAGE 1 EXPECTATIONS: Ongoing efforts to restore large expanses of tidal brackish and freshwater marsh will have continued and experimental pilot projects to restore tidal marshes to areas in the Suisun Marsh and San Pablo Bay and Delta islands will have been undertaken.

RESTORATION ACTIONS

The following action would help achieve tidal brackish marsh restoration:

- restore tidal flows to diked wetlands by breaching dikes in suitable areas;
- establish desirable estuarine salinity gradients by managing water diversions and water releases from upstream reservoirs to controls seasonal freshwater inflow into the Delta;
- balance seasonal flows from reservoirs for fisheries, water conveyance, flood control, and the need of other habitats;
- restore a more natural elevation gradient in wetlands to allow a greater diversity of native saline plants species, including special-status plant species that are adapted to different elevations and provide a broader range of habitats for wildlife.

Actions that would help restore tidal freshwater marsh include:

- setbacks or breaches of island levees to allow water flows to naturally reestablish wetland;
- increase land elevations in the interior of Delta islands where subsidence has lowered land elevation below tidal emergent wetlands;
- use of substrate materials to create levee berms at elevations necessary for freshwater marshes;
- modify, where consistent with flood control objectives, levee vegetation management practices to allow wetland vegetation to naturally establish;
- reintroduce native plants into suitable sites.

These protection and restoration strategies could be implemented by:

- establishing cooperative efforts between government and private agencies to coordinate the efficiency of implementing existing restoration strategies and plans;
- developing and implementing alternative land management practices on public lands to improve wetland habitat quality or promote habitat recovery, and provide incentives to private landowners to implement desirable land use practices;
- establish additional incentive programs to encourage landowners to establish and maintain freshwater marshes; and
- protecting existing habitat areas from potential future degradation through acquisition of conservation easements or purchase from willing sellers.

Restoration of stream meander belts and the process of overbank flooding along major tributaries to the Bay-Delta as proposed in the ERPP in other ecological management zones will also create the conditions necessary for the natural reestablishment of tidal brackish and freshwater marsh habitats elsewhere in the Central Valley.

SEASONAL WETLAND HABITAT PLANT COMMUNITY GROUP

INTRODUCTION

The Bay-Delta seasonal wetland habitat plant community group includes vernal pools and seasonally flooded areas. Vernal pools are probably best described as specialized components of terrestrial (land-based) habitats and requiring specific geomorphic features. Other seasonally flooded areas may be described as areas which flood for periods that are too long to support characteristic upland vegetation. Seasonally flooded areas may occur in low grassland basins, the perimeter of the permanent marshes, and within a stream course or its floodplain. Historically, seasonal wetlands occurred throughout the Central Valley. Loss of seasonal wetland habitat, vernal pools in particular, has directly resulted in the listing of several species as threatened or endangered under the federal Endangered Species Act.

Major factors that limit the contribution of this habitat type to the health of the Bay-Delta are related to adverse effects of land conversion, and substantial reductions in seasonal overbank flooding.

RESOURCE DESCRIPTION

Vernal pools are associated with soils (claypan, hardpan) that maintain standing water after winter and spring rains. In some areas of the Central Valley, high spring flows from the rivers and creeks saturate soils. Seasonal wetlands are created when puddles or small ponds form in depressions or standing water remains in low-lying grass fields after river flows recede. Although aquatic plants can establish in areas that are frequently flooded, upland plants cannot survive.

Vernal pools are seasonally flooded depressions formed where a barrier, such as a clay pan or cemented hard pan, restricts percolation of rainwater and runoff from adjacent areas during the winter rainy season. They support a distinctive herbaceous biota adapted to periodic or continuous inundation during the wet season and desiccated soils during the dry season (Holland and Jain 1977, Holland 1978, Thorne 1984, Zedler 1987, Jones & Stokes Associates 1990). Vernal pools usually occur in depressions between small mounds or ridges in a hummocky, rolling, or reticulated landscape. They vary in size from several yards to well over 1 acre and the largest pools are really seasonal lakes, like Olcott Lake at the Jepson Prairie Preserve in Solano County. Vernal pools are common in grasslands in northern Central Valley where the natural geomorphology remains relatively unchanged.

Species commonly found as dominants in vernal pools include goldfields (*Lasthenia* spp.), navarretia (*Navarretia leucocephala*), prostrate pigweed (*Polygonum arenastrum*), coyote thistle (*Eryngium* spp.), woolly marbles (*Psilocarphus* spp.), popcorn flowers (*Plagiobothrys* spp.), downingias (*Downingia* spp.), annual hairgrass (*Deschampsia danthonioides*), and common spikerush (*Eleocharis macrostachya*). Many State- and federally listed plants, invertebrates, and wildlife, including Contra Costa goldfields (*Lasthenia conjugens*), legenere (*Legenere limosa*), western spadefoot toad (*Scaphiopus hamondii*), California tiger salamander (*Ambystoma tigrinum*), and various fairy shrimp, are native to or associated with vernal pools. In addition, a variety of birds, including migrating waterfowl, shorebirds, and ground-nesting birds such as meadowlarks, commonly use seasonal wetlands habitat.

Vernal pools are best distinguished from one another by specific geomorphic features then by plant species composition. This is because the species composition and the relative cover by each species varies not only between pools, but varies from season to season within the pools. Two vernal pool ecosystem types are recognized in the Bay-Delta region. They are northern claypan vernal pools and northern hardpan vernal pools.

Northern claypan vernal pools contain mixo-saline water to freshwater ponded over claypans. They occur on neutral to alkaline, silica-cemented hardpan soils which are often saline. They are more widespread in the south San Joaquin Central Valley but range north into the Sacramento Central Valley area. Alkaline types of claypan vernal pools are characterized by a high alkaline salt content and dominance by plant species adapted to these conditions. Alkaline pools occur on extremely salty soils such as the Pescadero clay series underlying Olcott Lake in the Jepson Prairie Preserve. Alkaline pools support common alkaline plants such as alkali heath (*Frankenia salina*), alkali

mallow (*Malvella leprosa*), and alkali weed (*Cressa truxillensis*). Some special status plants found in alkaline pools include bearded popcorn flower (*Allocarya histriculus*), Solano grass (*Tuctoria mucronata*), and Colusa grass (*Neostapfia colusana*).

Northern hardpan vernal pools contain mixo-saline water to freshwater impeded by hardpans. They occur on old, acidic, iron-silica cemented soils including Corning, Redding, and San Joaquin soil series. They are typically found on old alluvial fans ringing the Central Valley.

Seasonally flooded areas play a vital role in the natural succession of plant communities. Seasonally flooded areas that maintain surface water for long periods may support herbaceous plant dominants in three recognized plant communities - cattails, bulrushes, and sedges. Historically, these emergent plant species were probably prevalent along natural stream courses where long-standing water reduced the ability of upland species to establish. These types of wetlands provide the essential building blocks for the future establishment of riparian (streambank) scrub and eventually riparian woodland. Beyond the normal river flows, wetlands probably formed where rains and high flows left areas too wet for terrestrial plants to establish. These wetland areas provide high-quality habitat for a special status plant, Sanford's arrowhead (*Sagittaria sanfordii*), and a variety of wildlife including waterfowl, other migratory birds, shorebirds, red-legged frogs, giant garter snakes, and tricolored blackbirds.

The continued existence of the seasonal wetland habitat plant community group is closely linked to overall ecosystem integrity and health. Although many species that use seasonal wetlands are migratory (e.g., waterfowl and sandhill cranes), many others have evolved (e.g., spadefoot toad, fairy shrimp, and many specialized plants) and adapted to seasonal wetlands.

The extent and quality of the seasonal wetland habitat plant community group has declined because of cumulative effects of many factors, including:

- modification of natural geomorphology such as ground leveling for agriculture and development,
- adverse effects of overgrazing,
- contamination from herbicides,
- establishment of non-native species that have an adverse effect on native wetland plants and wildlife,
- flood control and water supply infrastructure that reduces overbank flooding and floodplain size, and
- reduction of the natural underground water table that supported wetlands.

Existing wetland regulations have been in effect for several years in an attempt to prevent the further loss of wetlands. The protected status of wetlands has resulted in an extensive permitting process for construction in wetland areas. Mitigation measures have been developed to offset loss of existing wetlands as a result of construction activities. These efforts have slowed the rate of wetland loss in many areas. Large-scale efforts in areas such as the Suisun Marsh, Grasslands Resource Conservation District, Yolo Bypass, Cosumnes River Preserve, Jepson Prairie Preserve, and Butte Sink have been successful in maintaining and restoring seasonal wetlands.

VISION

The vision for the seasonal wetland habitat plant community group is to improve the quality and extent of these habitat plant community group by restoring ecosystem processes that sustain them, preserving and enhancing their linkage to important other habitat plant community groups and reducing the effect of stressors.

Restoration of seasonal wetland habitat will focus on protecting and improving important existing wetlands, reestablishing vernal pools within and adjacent to existing ecological reserves, and restoring seasonal wetlands in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Management Zones. Seasonal wetland restoration will be coordinated with restoration of other habitats, including shallow-water and riparian woodland and scrub. Restoration would include reestablishment of the full diversity of seasonal wetland plant associations to ensure that the habitat needs of special-status and other species that are dependent on specific vegetation associations are met.